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DOMESTIC URANIUM EXPLORATION ACTIVITIES

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INTRODUCTION

Uranium exploration in the United States reached its all-time high in 1978 when the chief exploration indicator, surface drilling, totaled 47 million feet. In 1979, however, total drilling declined to 41 million feet, and during the first half of 1980 the trend continued, as surface drilling was 37 percent less than for the same period in 1979. The total drilling for 1980 now is expected to be below 28 million feet, far less than the 39.4 million feet planned by industry at the beginning of the year.

Falling uranium prices, the uncertainties of future uranium demand, rising costs, and the possibility of stiff foreign competition are the prime causes for the current reduction in domestic uranium exploration. Many of the utilities that were participating directly in exploration ventures are withdrawing their backing. Some domestic exploration companies are becoming more selective in their activities in this country and are examining possibilities of exploring outside the United States where the chances of finding large low-cost uranium deposits may be better. At the same time, there are exploration companies that say they are in the business for the long haul and that they plan to continue their activities at an unreduced pace. Needless to say, the overall effect is one of confusion.

It is important to note that even with the substantial decreases in exploration during the last 2 years new orebodies were being found and extensions to previously discovered orebodies were being made. Admittedly, most of these discoveries were related to major districts and generally were high cost and low in grade. However, the potential for finding much more uranium in the United States is excellent but will require more favorable economic conditions and a firm demand to be realized.

EXPLORATION HIGHLIGHTS

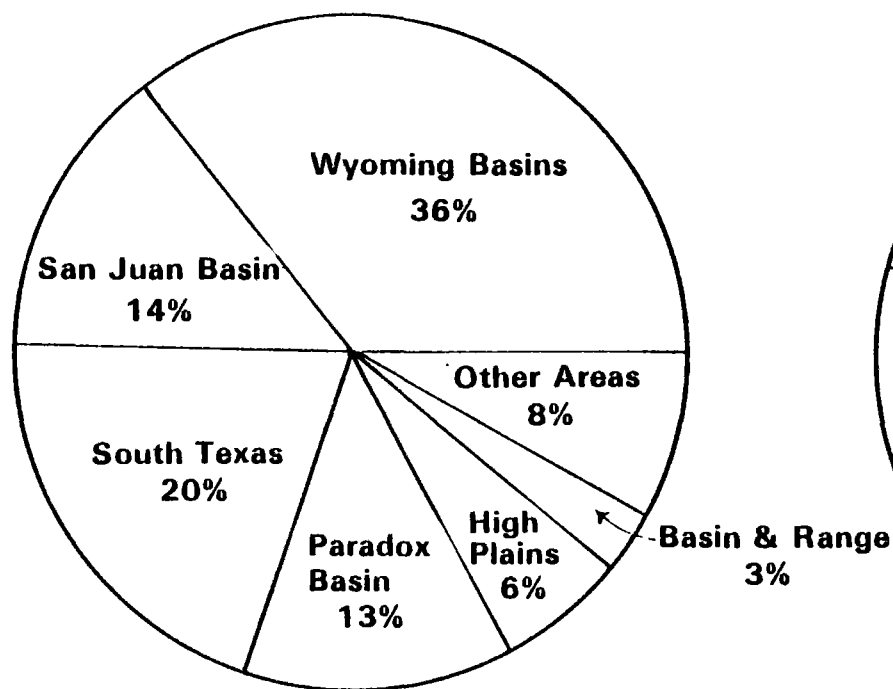
Uranium exploration in the United States continues to be concentrated in the vicinity of major producing areas such as the San Juan Basin, Wyoming Basins, Texas Coastal Plain, Paradox Basin, and northeastern Washington, and in areas of recent discoveries including the Henry Mountains, Utah, the McDermitt caldera in Nevada and Oregon, and central Colorado. The distributions, by location, of total surface drilling for 1979 and the first half of 1980 are shown in Figure 1. Of the 9.3 million feet reported for the first half of 1980, the Wyoming Basins (led by the Powder River Basin) account for 28 percent, south Texas--20 percent, San Juan Basin--18 percent, and Paradox Basin--16 percent. Drilling in the western Great Plains, which includes the Black Hills, and in the Basin and Range account for 5 and 3 percent, respectively. No major discoveries in new geologic environments were reported during the past field season; however, a significant discovery in Tertiary sediments in the Green Mountain area of central Wyoming was announced late in 1979.



FIGURE 1

DISTRIBUTION OF URANIUM DRILLING BY LOCATION

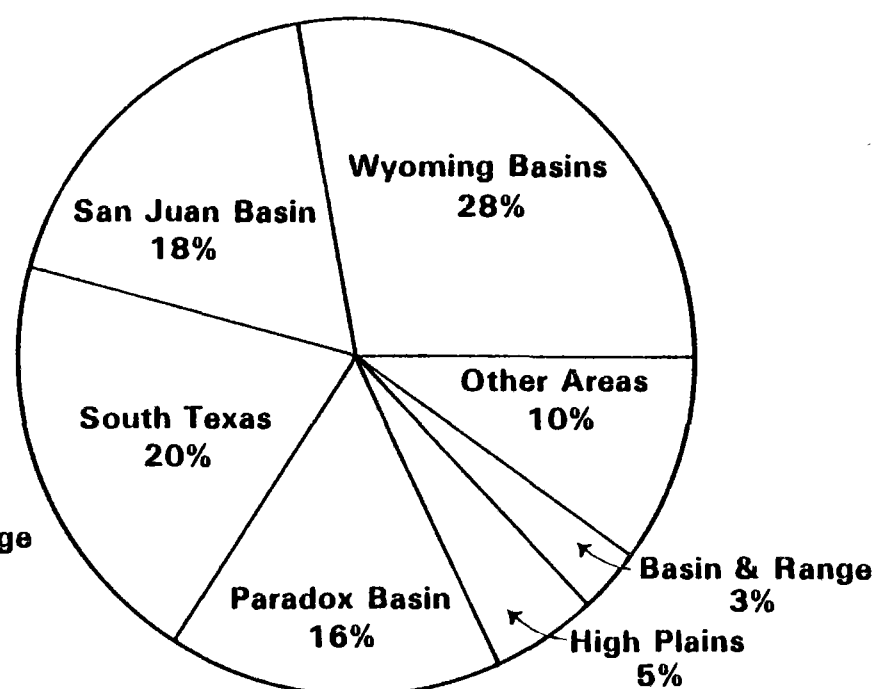
1979
January-December



40.8 Million Feet
Average depth 450 Feet

66% Exploration
34% Development

1980
January-June



9.3 Million Feet
Average Depth 456 Feet

60% Exploration
40% Development

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Nonsandstone Environments

Exploration in nonsandstone environments decreased in 1979 after reaching a high in 1978. Figure 2 shows the number of exploration companies and their expenditures in these environments. The number of companies reporting nonsandstone activities increased from 72 in 1977 to 90 in 1978, and was 87 in 1979. The related expenditures increased from \$34 million in 1977 to a high of \$62 million in 1978 and were \$59 million in 1979. In 1979, expenditures in nonsandstone environments amounted to 19 percent of the total exploration funds spent in the United States, approximately the same percentage as in 1978.

FIGURE 2
EXPLORATION IN NONSANDSTONE
ENVIRONMENTS

<u>Year</u>	<u>Number of Companies</u>	<u>Millions of Dollars</u>	<u>Percent of Total Expenditures</u>
1974	39	12.9	16.3
1975	39	13.6	11.3
1976	51	28.5	16.7
1977	72	33.8	13.1
1978	90	61.9	19.7
1979	87	59.4	18.8
1980 planned	79	52.9	19.1
1981 planned	59	55.8	20.6

In west-central Alaska there has been exploration in the Hogatza belt of Cretaceous alkalic plutons (Fig. 3). In central Alaska, the Sischu Creek radioactive anomaly, located by NURE quadrangle investigations and verified by NURE flying, has been the site of land acquisition and geologic investigations. This large anomaly is in an area of felsic intrusive and extrusive rocks of Cretaceous-Tertiary age. Exploration continued during the past field season at the Mt. Prindle occurrence, northeast of Fairbanks, in early Tertiary crystalline rocks.

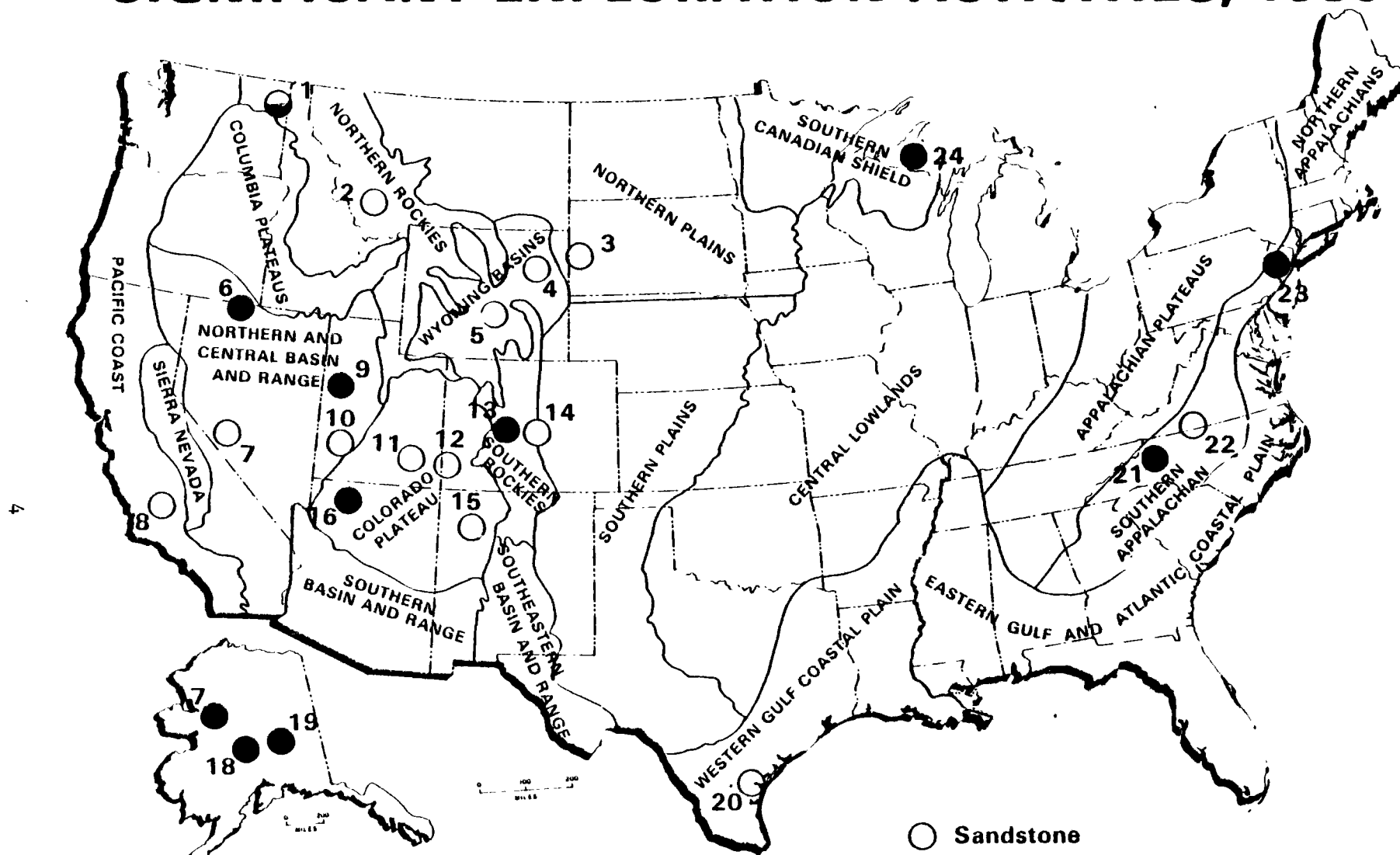
Gneissic domes and the margins of granitic plutons are being evaluated in northeastern Washington and elsewhere in the Rocky Mountains and in the Basin and Range province.

Exploration continued in the McDermitt volcanic caldera of Nevada and Oregon, where uranium deposits have been found in stratiform volcanoclastics and in veins. Volcanoclastic rocks are also a target in the Spor Mountain, Utah, area.

Vein-type deposits associated with fault breccias in rocks of various geologic ages are being sought in central Colorado. Breccia-pipe deposits in Paleozoic sedimentary rocks are targets in northwestern Arizona. Exploration is continuing in Precambrian rocks of the southern Canadian Shield in the Upper Peninsula of Michigan and in northern Wisconsin, where both unconformity and quartz-pebble conglomerate types of deposits are sought.

FIGURE 3

SIGNIFICANT EXPLORATION ACTIVITIES, 1980



Significant Exploration Activities, 1980

- | | | |
|-----------------------|-----------------------|--------------------------|
| 1. NE Washington | 9. Spor Mountain | 17. Hogatza |
| 2. SW Montana | 10. Beaver Valley | 18. Sischu Creek |
| 3. Black Hills | 11. Henry Mountains | 19. Mt. Prindle |
| 4. Powder River Basin | 12. Paradox Basin | 20. South Texas |
| 5. Central Wyoming | 13. Gunnison | 21. Grandfather Mountain |
| 6. McDermitt Caldera | 14. Tallahassee Creek | 22. Triassic Basins |
| 7. East Walker River | 15. San Juan Basin | 23. Reading Prong |
| 8. Taft-McKittrick | 16. NW Arizona | 24. N Michigan |

- Sandstone
- Nonsandstone
- ◐ Sandstone and nonsandstone

In the Appalachians, in spite of land-acquisition problems, exploration resumed in both the Grandfather Mountain area of North Carolina and in the Reading Prong of northern New Jersey, southern New York, and eastern Pennsylvania, where uranium occurs in Precambrian crystalline rocks.

Sandstone Environments

Exploration in sandstone environments continues to be predominantly in the uranium-producing areas. During the first half of 1980, the Colorado Plateau, Wyoming Basins, and Texas Coastal Plain accounted for 87 percent of the total industry drilling reported to the Grand Junction Office. The Powder River Basin in Wyoming, which had 17 percent of the total 1979 domestic drilling, continues to lead all areas with 20 percent at mid-year. In this basin, sandstones of Paleocene and Eocene age are the targets. Eocene sandstones in the Wind River, Shirley, and Great Divide Basins of Wyoming also are being explored. In December 1979, an announcement was made of the discovery of a 20,000-ton deposit of U_3O_8 in the Green Mountain area of central Wyoming at an average depth of 3,300 feet. The deposit occurs in the Battle Spring Formation, and the ore grade averages 0.23 percent U_3O_8 . This was the most important new discovery announced in the past 12 months.

Drilling in the San Juan Basin of northwestern New Mexico, predominantly for deposits in the Morrison Formation of Jurassic age, amounted to 14 percent of the Nation's total in 1979 and 18 percent in the first half of 1980. However, the recent decline in drilling in the basin is expected to cause the overall 1980 percentage to drop several points by year end. Drilling is continuing in the Grants mineral belt and on the Navajo Reservation, but much of the deeper drilling north of the mineral belt has ceased.

The Paradox Basin of southwestern Colorado and southeastern Utah is the site of extensive drilling in both the Morrison and Chinle (Triassic) Formations. At mid-year, the basin accounted for 16 percent of the total national drilling. However, at year-end the percentage of the total is likely to be less due in part to the termination of operations on several DOE lease blocks. West of the Paradox Basin in the Henry Mountains significant exploration continues in the Salt Wash Member of the Morrison Formation.

Although two utility companies have cancelled exploration programs in southeastern Utah and adjacent areas, Energy Fuels Nuclear's new mill near Blanding, Utah, provides a market for independent producers and hence will encourage exploration in surrounding areas.

The Tertiary basins of southeastern Montana continued to be explored for Wyoming-type roll-front deposits. The outcome of the vote in November on a proposed state law which would require all mined ore and associated radioactive waste to be removed from the state will affect future exploration.

Exploration continues in the Black Hills in spite of increasing pressure from anti-nuclear groups in South Dakota. Deposits are being sought in sandstones of the Inyan Kara Group of Early Cretaceous age.

Paleochannels filled with Tertiary sediments, similar to the geologic setting that contains the deposits at Tallahassee Creek, are being explored in the Colorado Rockies.

South Texas continues to be one of the most active areas in the United States. During 1979, and so far in 1980, it accounted for 20 percent of total domestic drilling. By the end of 1980, the percentage is expected to increase. The chief targets are deeper Tertiary sandstones, which may contain ore deposits suitable for solution mining.

Several private companies have been active in the intermontane basins of the Basin and Range province. The East Walker River area of southwestern Nevada and the Beaver Valley of southwestern Utah have been sites of significant drilling. In the Taft-McKittrick area of southern California, sandstone beds in the Santa Margarita Formation of Miocene age is being explored.

Sandstones in the Triassic basins in the eastern United States also are being investigated for uranium deposits, especially in Virginia.

EXPLORATION EXPENDITURES AND RELATED STATISTICS

Each spring the Grand Junction Office conducts a survey, by individual company, of the uranium industry's exploration activities during the preceding year and plans for the next 2 years. The results of the latest survey were published in, "Uranium Exploration Expenditures in 1979 and Plans for 1980-1981", GJO-103(80), which presents a compilation of data from 164 responding companies. The following information is taken from this survey.

Figure 4 is a summary of exploration expenditures for land acquisition, drilling, and other costs for 1972-79. The \$316 million spent in 1979 was approximately 1 percent greater than that reported in 1978. In 1979, foreign participation in uranium exploration in the United States amounted to \$34.1 million or about 11 percent of total exploration expenditures, compared with 13 percent in 1978.

Of the 164 survey respondents, 134 planned to spend a total of \$277 million in 1980, a decrease of 12 percent from 1979. Planning of 1981 activities by some companies was incomplete at the time of the survey, but the 98 companies that did report expect to spend \$271 million in 1981.

Land Acquisition

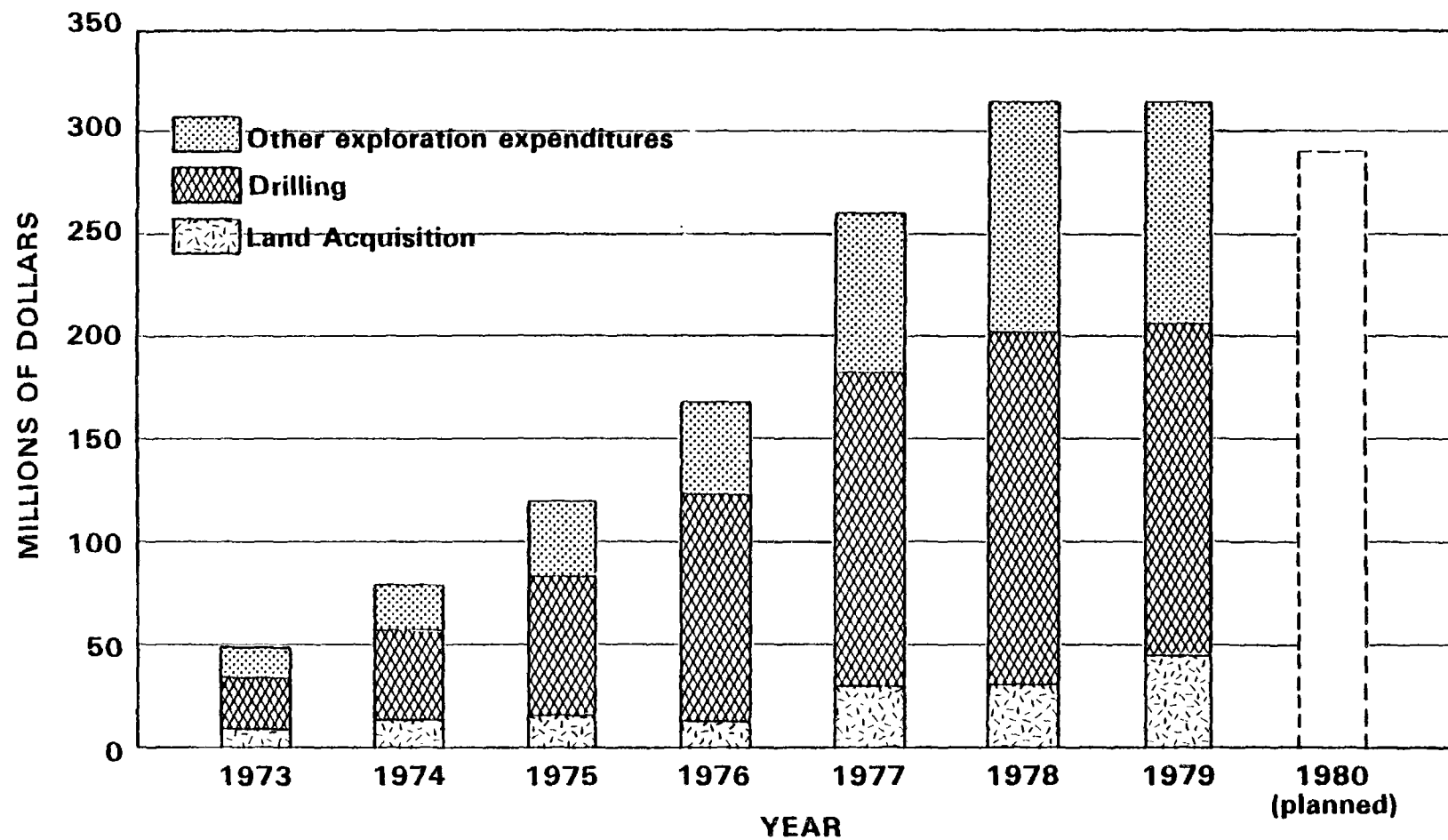
The cost of acquiring land remains a significant part of uranium exploration costs. For example, in 1979 this cost represented 14 percent of total exploration expenditures. Acquisition costs during 1979 ranged from less than 50 cents to more than \$500 per acre, and averaged more than \$10 per acre. A state lease sale in New Mexico, where orebodies were delineated by earlier drilling, contributed to the higher than average per acre cost.

A survey of recorded land transactions for mineral purposes in 14 western states during 1979 indicates that 3,055,000 acres were acquired for uranium exploration. Nearly 77 percent of these acres consisted of mining-claim locations on Federal lands, 22 percent were fee lands, and 1 percent were Indian lands.

Figure 5 is a summary of the estimated distribution of the January 1, 1979, \$50 per pound U_3O_8 forward-cost uranium resources by land status. It shows that 48 percent of the reserves are on public lands, 39 percent on private lands, 10 percent on Indian lands, and 3 percent on state lands.

FIGURE 4

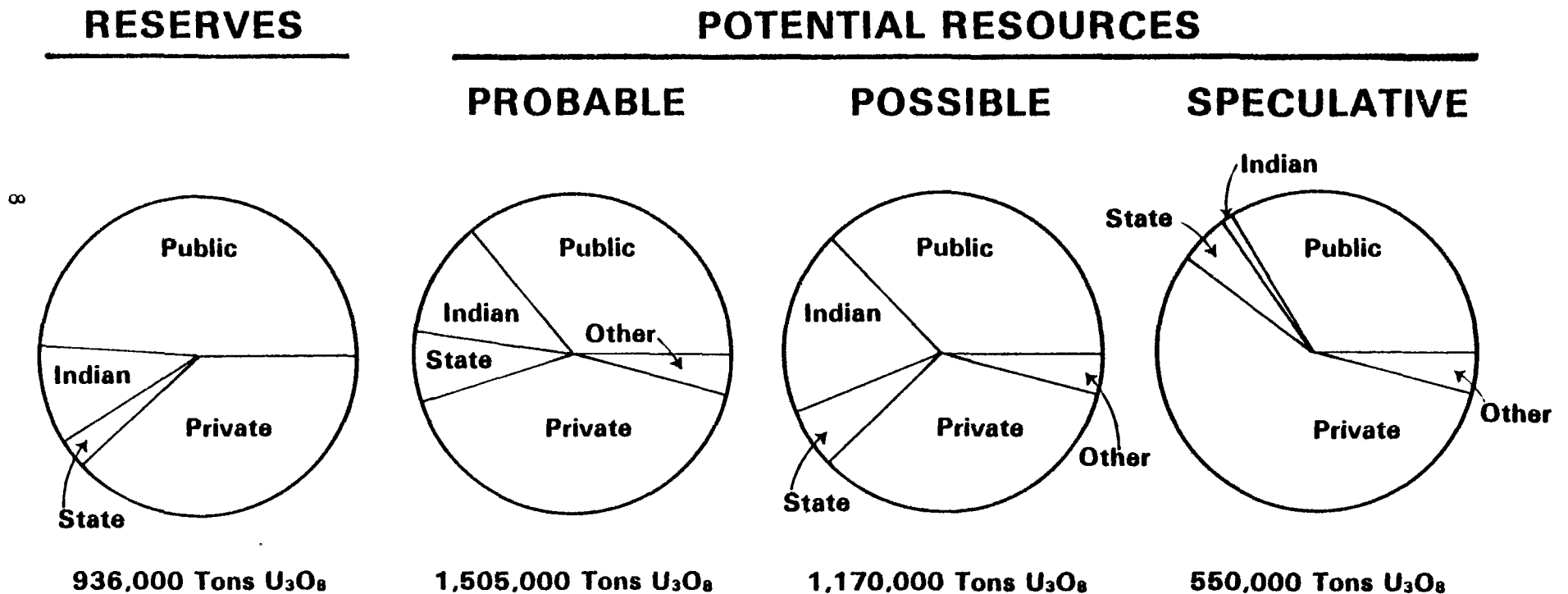
SUMMARY OF ANNUAL DOMESTIC EXPLORATION EXPENDITURES



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FIGURE 5

DISTRIBUTION OF URANIUM RESOURCES BY LAND STATUS \$50 PER POUND U_3O_8 JANUARY 1, 1980



NOTE—The category "Other" includes military reservations, wilderness areas, national recreation areas, wildlife refuges, powersite withdrawals, etc.

Figure 5 also shows that most of the estimated potential resources are on public and private lands.

Drilling

Drilling is the most expensive exploration activity and generally accounts for more than half of total exploration expenditures. Figure 6 is a historical summary of surface drilling and related costs for industry's exploration and development efforts for 1966-79 and plans for 1980-81. Total footage drilled in 1979, for which costs were reported, was about 15 percent less than the footage drilled in 1978, and total drilling costs were 4 percent less than in 1978. The total footage drilled does not include drilling from underground workings or for solution mining. In addition to drilling operations, surface drilling costs include drill-road construction, site preparation, geologic and other technical support, sampling, drill-hole logging, and site restoration. Combined, these drilling-related costs ranged from less than \$1.25 to more than \$30 per foot. The average cost was \$3.97 per foot, a 12 percent increase over 1978.

FIGURE 6
SUMMARY OF SURFACE DRILLING EXPENDITURES

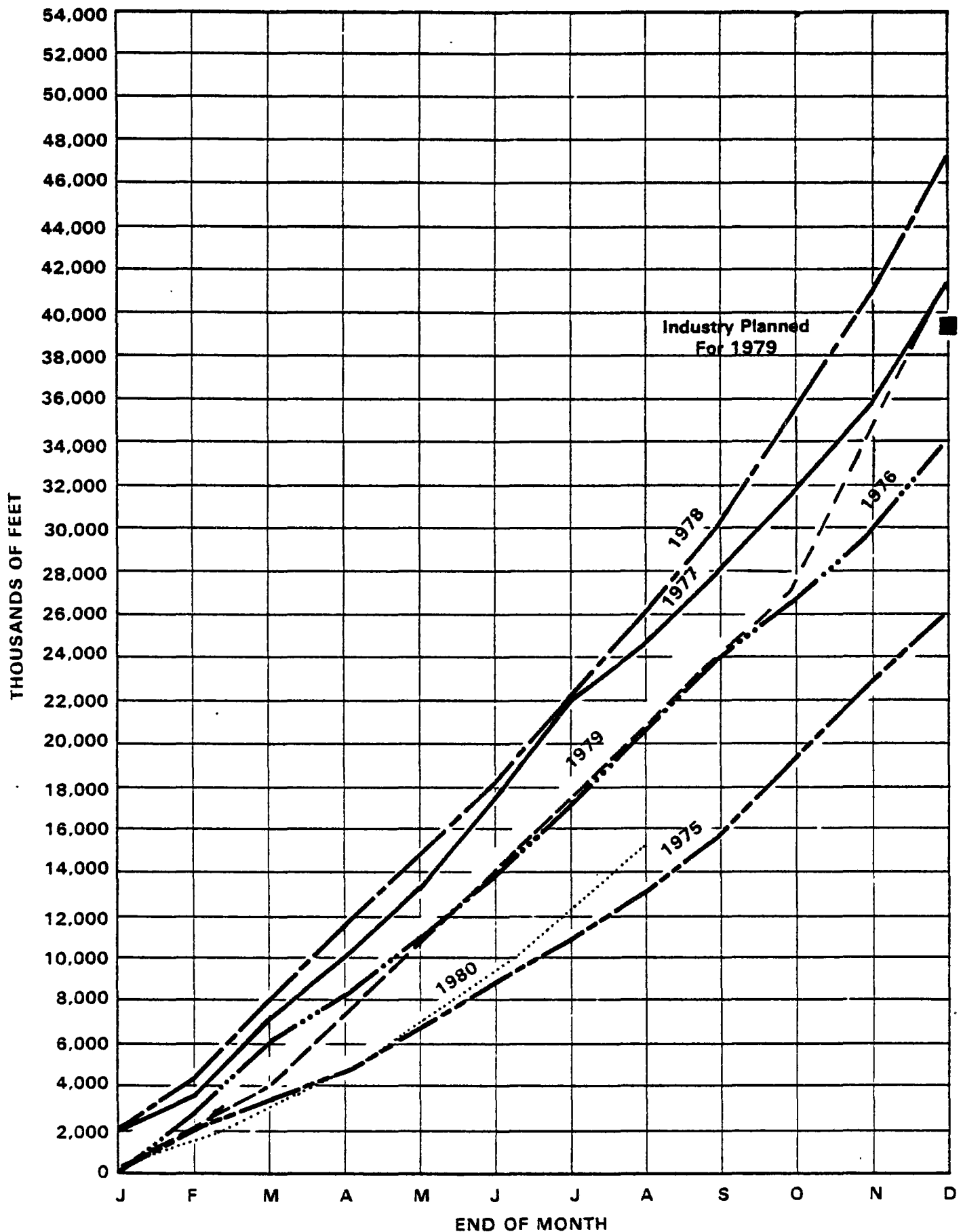
Year	Exploration Drilling		Development Drilling		Total Surface Drilling	
	Millions of Feet*	Millions of Dollars	Millions of Feet*	Millions of Dollars	Millions of Feet*	Millions of Dollars
1966	0.93	1.36	1.50	1.24	2.43	2.60
1967	3.87	6.18	2.92	2.32	6.79	8.50
1968	12.87	18.53	3.73	2.82	16.60	21.35
1969	19.69	24.85	4.79	4.34	24.48	29.19
1970	16.91	21.69	3.41	3.49	20.32	25.18
1971	11.80	17.01	3.08	3.95	14.88	20.96
1972	11.95	15.40	3.08	2.70	15.03	18.10
1973	11.76	19.50	5.25	5.80	17.01	25.27
1974	14.72	34.95	6.84	9.81	21.56	44.76
1975	15.69	51.92	9.73	21.89	25.42	73.81
1976	20.36	70.70	14.44	38.30	34.80	109.00
1977	27.96	99.40	17.62	55.83	45.48	155.03
1978	28.95	113.30	19.15	56.40	48.10	169.68
1979	28.07	119.60	13.01	43.40	41.08	163.00
1980 planned	27.90	—	11.50	—	39.40	—
1981 planned	24.70	—	10.80	—	35.50	—

*From 1966-1972, 15.2 million feet of exploration and development drilling were not reported separately and are not included above.

According to the 1980 exploration survey, industry planned to drill 39.4 million feet in 1980 and 35.5 million feet in 1981. Figure 7 shows the amount of annual drilling from 1975-79 and for the first 3 months of 1980. Based on current data, it appears that total drilling for 1980 may not exceed 28 million feet, falling far short of the planned 39.4 million feet.

Exploration drilling, which is done to find new ore deposits or extensions of known deposits, accounted for 66 percent of all 1979 drilling. Development drilling, which defines the shapes, sizes, and grades of deposits and provides information needed for mine planning, accounts for the balance. In 1979, drilling utilized an estimated 370 drill rigs and 380 logging trucks. This compares with 375 rigs and 370 logging trucks used in 1978.

FIGURE 7
CUMULATIVE URANIUM DRILLING AS COLLECTED MONTHLY
Comparing 1975, 1976, 1977, 1978, 1979, and 1980



Figures 8 and 9 show the regional distribution of exploration and development drilling for the years 1970-79. Exploration drilling in 1979 decreased in nearly all regions with the exceptions of south Texas and central Wyoming. Development drilling in 1979 increased over 1978 in central Wyoming, the Paradox Basin, and elsewhere, including other portions of the Colorado Plateau and the Wyoming Basins and in the Black Hills.

Figure 10 shows a drilling analysis by selected depth ranges for 1964-79. The average depth of all holes drilled for uranium in 1979 was 450 feet, the same as in 1978; for the first half of 1980 it was 456 feet (Fig. 1). So far this year, the average depth of holes drilled in the San Juan Basin has been 1,292 feet; whereas the average depth has been 404 feet in the Wyoming Basins and 308 feet in south Texas.

Other Exploration Costs

Other exploration costs, shown on Figure 4, include those for geologic and geophysical investigations and research, costs incurred by field personnel during exploration, and overhead and administrative charges specifically associated with supervising and supporting exploration activities. In 1979, these types of costs represented 34 percent of the total reported exploration expenditures. The \$108.40 million spent in 1979 represents a decrease from the \$113.85 million spent in 1978. Environmental studies required prior to the conduct of exploration programs are becoming more involved and costly. These studies, combined with increased use of geochemical and geophysical surveys, account for most of the other costs.

FOREIGN URANIUM EXPLORATION

Twenty-four U.S. companies reported spending over \$43 million for uranium exploration in foreign countries in 1979. This was 20 percent more than in 1978. Figure 11 summarizes the uranium expenditures by private companies reporting for the period 1966-70, for the individual years 1971-79, and the planned expenditures for 1980-81. Australia, Canada, Africa, West Germany, and Latin America are the areas receiving the most interest by U.S. firms.

FIGURE 11

FOREIGN URANIUM EXPLORATION EXPENDITURES BY U.S. COMPANIES

Year	Number of Companies	Millions of Dollars
1966-1970	14	13.52
1971	6	1.65
1972	8	1.94
1973	11	3.34
1974	12	4.53
1975	14	5.10
1976	14	18.80
1977	19	31.16
1978	20	35.89
1979	24	43.24
1980 planned	22	42.16
1981 planned	22	46.41

FIGURE 8
URANIUM EXPLORATION DRILLING BY AREA
1970 THROUGH 1979

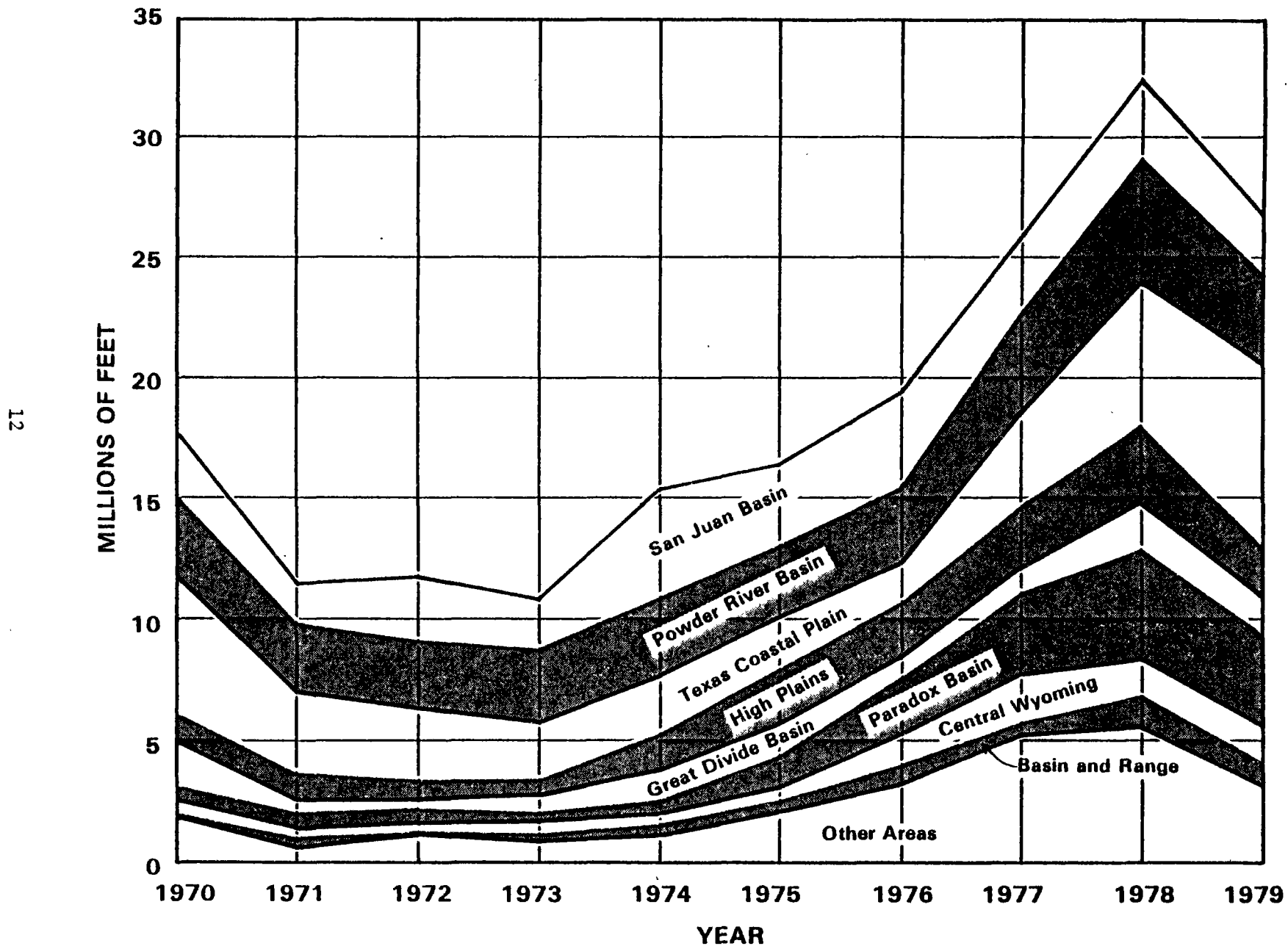
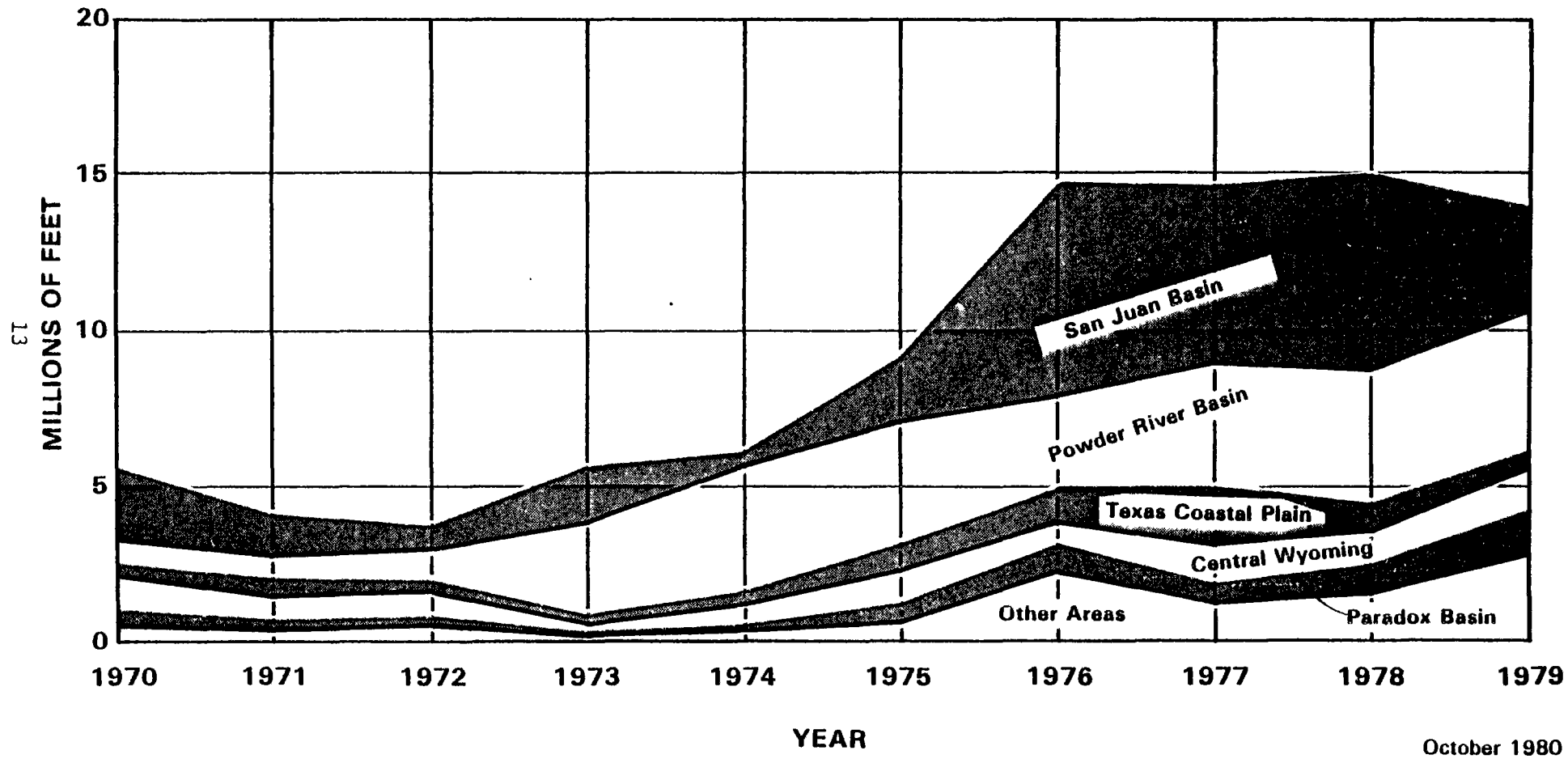


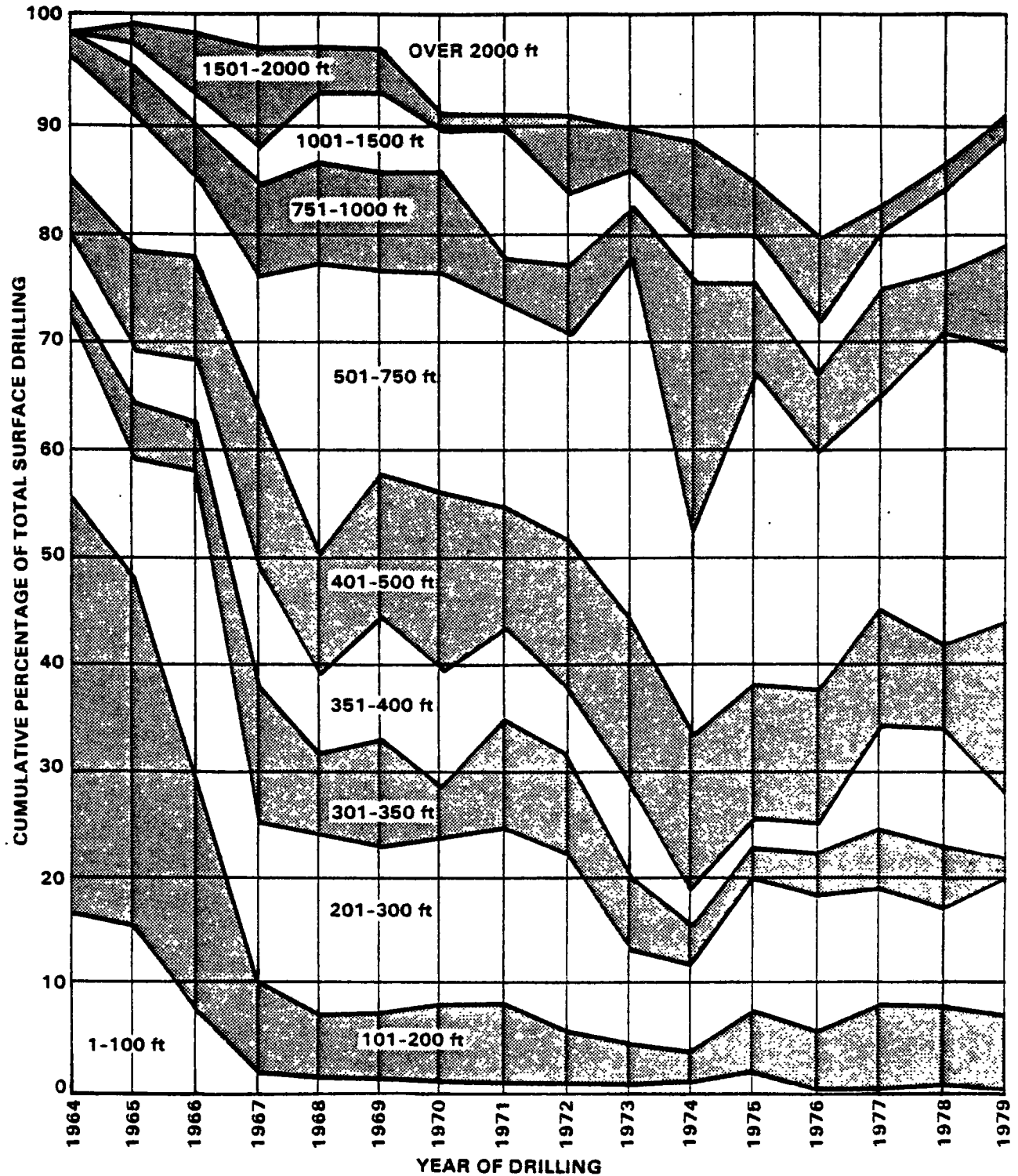
FIGURE 9
URANIUM DEVELOPMENT DRILLING BY AREAS
1970 THROUGH 1979



October 1980

FIGURE 10

PERCENTAGE OF URANIUM DRILLING BY SELECTED DEPTH RANGES 1964-1979



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OUTLOOK FOR URANIUM EXPLORATION

The uranium exploration industry is confronted with a myriad of concerns in addition to the current major problems of low prices, high costs, weak demand, and possible foreign competition. These other concerns include large land withdrawals from mineral entry at Federal and state levels, ever increasing environmental and safety regulations, opposition of groups opposed to nuclear power, and the basic fact that many explorations targets are deeper and more difficult to select. To cope with these and associated problems will require tremendous efforts which will not be undertaken by the industry in any concerted manner until uranium market conditions are improved considerably.

Therefore, it is expected that domestic exploration, particularly large drilling programs, will continue to decline for the next several years, although perhaps at a reduced rate. During this slack period, many companies will concentrate on the development of new or improved geologic exploration concepts and models for future application to both sandstone and nonsandstone environments. As an indication of this, presently more reports and documents are being issued by the Grand Junction Office's technical library than at any other time in its history.

It is still believed that the long-term outlook for uranium exploration in the United States is bright. Through company efforts and the efforts of the Department of Energy's National Uranium Resource Evaluation (NURE) program, there have been many areas described that could contain large uranium deposits. The demand for uranium, although soft at present, is predicted to require 30,000 to 40,000 tons U_3O_8 annually in the next 10 to 20 years. Much of the estimated potential uranium resources must be converted into reserves if there is to be a viable, self sufficient, domestic nuclear power industry entering into the next century. As Paul deVergie will emphasize in his paper, because of the long lead times needed to convert potential resources to reserves, aggressive exploration programs should continue if future demand is to be met from domestic sources.

The short-term exploration picture is cloudy--much will depend on the direction that national energy policies take. I know that many of us will be impatiently awaiting the results of the Grand Junction Office's next survey of the expenditures and plans of the exploration industry, which will start after the first of the year.